4/5

Birzeit University
Mathematics Department
Math. 243

M. Saleh

qz3- Spring Semester 2014/2015

Student Name: Rasha Shadeed Number: 1130981 Section 1

Q1 (5 points) Prove or disprove each of the following:

1 (1) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B^c$.

2 (2) $A - B = A \bigcap B^c$.

— (3) State De Morgan's Laws $\cap$ $\cup$ $A \cap B = A$ $A \cap B$

1 (4) If $A \subseteq B$, then $A^c \subseteq B^c$

(1) $A \cap B = \emptyset \longrightarrow$ then $A \subseteq B^c$

~~let $x \in (A \cap B = \emptyset)$~~

let $x \in A$ ~~to~~ we need to show $x \in B^c$ 1/1

$x \in A$ and $A \cap B = \emptyset$, then $x \notin B$ so $x \in B^c$

$\therefore$ then $A \subseteq B^c$

---

(2) $A - B = A \cap B^c$ 1/2

let $x \in (A - B)$ ~~we~~ we need to show $x \in (A \cap B^c)$

$x \in A$ and $x \notin B$ $\longrightarrow$ so $x \in A$ and $x \in B^c$

so $x \in (A \cap B^c)$

$A - B \subseteq A \cap B^c$

let $x \in A \cap B^c$ we need to show $A - B$.

let $x \in A \cap B^c \in \longrightarrow$ so $x \in A$ and $x \in B^c \longrightarrow$

~~so $x \in B$~~ so $x \in A$ and $x \notin B \longrightarrow$

so $x \in (A - B)$

$A \cap B^c \subseteq A - B$

111

so $A \cap B^c \subseteq A - B$.

$\boxed{4}$ if $\overset{T}{A \subseteq B}$ then $\overset{F}{A^c \subseteq B^c}$

$U = \{1, 2, 3, 4, 5\}$

$A = \{1, 2\}$ $B = \{1, 2, 3, 4\}$

111

$A^c = \{3, 4, 5\}$ $B^c = \{5\}$

$A^c \not\subseteq B^c$

$\boxed{3}$ De Morgan Low :-

$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$

$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$

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Math. 243

M. Saleh

qz3- Spring Semester 2014/2015

Student Name: Abrar Farouq Alnaeid **Number:** 1121765 **Section 1**

Q1 (5 points) Prove or disprove each of the following:

A B

(1) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B^c$.

2 (2) $A - B = A \bigcap B^c$.

1 (3) State De Morgan's Laws

1 (4) If $A \subseteq B$, then $A^c \subseteq B^c$

Let A, B are two sets $A \cap B = \phi$. we need to show $A \subseteq B^c$.

~~Let $x \in A \cap B = \phi$~~

~~let so $x \in A$ ~~and~~ so $x \notin B$~~

~~so $x \in A$. and $x \notin B^c$.~~

~~so $x \in A$~~

~~so $A \subseteq B^c$~~

X

~~0.5/1~~

(2) $A - B = A \cap B^c$

LHS $\subseteq$ RHS

Let $x \in A - B$

so $x \in A$ and $x \notin B$.

so $x \in A$ and $x \in B^c$.

so $x \in (A \cap B^c)$

so $A - B \subseteq A \cap B^c$

2/2

RHS $\subseteq$ LHS

Let $x \in A \cap B^c$

so $x \in A$ and $x \in B^c$.

so $x \in A$ and $x \notin B$.

so $x \in (A - B)$

so $A \cap B^c \subseteq A - B$

So $A - B = A \cap B^c$.

(3) $(A \cup B)^c = A^c \cap B^c$

$(A \cap B)^c = A^c \cup B^c$

1/1

(4) If $A \subseteq B$, then $A^c \subseteq B^c$., False.

$U = \{1,2,3,4,5,6,7,8,9,10\}$.

$A = \{1,2,3\}$ $A^c = \{4,5,6,7,8,9,10\}$

$B = \{1,2,3,4\}$. $A^c = \{5,6,7,8,9,10\}$

~~Let $A = \{1,2,3\}$, $B = \{4,5,6,7\}$.~~

~~$A^c = \{4,5,6,7,8,9\}$, $B^c = \{1,2,3,8,9\}$~~

~~Let $A = \{1,2,3\}$, $B = \{1,2,3,4,5,6,7,8,9\}$.~~

~~so $A \subseteq B$~~

~~$A^c \subseteq \{$~~

1/1

Use Counter example.

$A \subseteq B$?? $\Rightarrow$ $A^c \overset{?}{\subseteq} B^c$

$\{1,2,3\} \subseteq \{1,2,3,4\}$

$\{4,5,6,7,8,9,10\} \subseteq \{5,6,7,8,9,10\}$.

false

& $\boxed{A^c \not\subseteq B^c}$

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M. Saleh

qz3- Spring Semester 2014/2015

Student Name: Athar Isya Albeek **Number:** 1120524 **Section 1**

Q1 (5 points) Prove or disprove each of the following:

(1) If A, B two sets such that $\boxed{A \bigcap B = \phi.}$ $\boxed{\text{Then } A \subseteq B^c.}$

2 (2) $A - B = A \bigcap B^c$.

1 (3) State De Morgan's Laws

1 (4) If $A \subseteq B$, then $A^c \subseteq B^c$

1 Let A, B two sets $A \cap B = \phi$ we need to show $A \subseteq B^c$

Let $x \in A \cap B = \phi$

so $x \in A$ and $x \in B$

so $x \in A$ and $x \notin B^c$

~~so $x \notin A$~~

[3] ① $(A \cap B)^c = A^c \cup B^c$

② $(A \cup B)^c = A^c \cap B^c$

1|1

---

[2] $A - B = A \cap B^c$

LHS $\subseteq$ RHS

let $x \in A - B$

so $x \in A$ and $x \notin B$

so $x \in A$ and $x \in B^c$

so $x \in A \cap B^c$

so LHS $\subseteq$ RHS

2|2

RHS $\subseteq$ LHS

let $x \in A \cap B^c$

so $x \in A$ and $x \in B^c$

so $x \in A$ and $x \notin B$

so $x \in (A - B)$

so LHS = RHS

---

[4] $A \subseteq B$ then $A^c \subseteq B^c$ (False

Counter Example $U = \{1,2,3,4,5,6,7,8,9,10\}$

$A = \{1,2,3\}$

$B \{1,2,3,4,5\}$

$A^c = \{4,5,6,7,8,9,10\}$

$B^c = \{6,7,8,9,10)$

$\Rightarrow A^c \not\subseteq B^c$

but $B^c \subseteq A^c$

1|1

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M. Saleh

qz3- Spring Semester 2014/2015

Student Name: Hadeel Sehwail Number: 1121562 Section 1

Q1 (5 points) Prove or disprove each of the following:

(1) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B^c$.

2 (2) $A - B = A \bigcap B^c$.

1 (3) State De Morgan's Laws

(4) If $A \subseteq B$, then $A^c \subseteq B^c$

① let A, B Two sets such that $A \cap B \neq \phi$, ~~then A~~
we need to show $A \subseteq B^c$

* $x \in A$ and $x \in B$.
* $x \in A$ and $x \notin B^c$

then $x \in A$ and

④ $A = \{1, 2, 3\}$, $B = \{4, 3, 6, 7\}$

$U = \{1, 2, 3, 4, 5, 6, 7\}$

$A \subseteq B$, $A^c \not\subseteq B^c$

$\{1, 2, 3\} \subseteq \{4, 3, 6, 7\}$

3- ③ (1) $(A \cup B)^c = A^c \cap B^c$
(2) $(A \cap B)^c = A^c \cup B^c$

1/1

---

④ ~~If $A \subseteq B$, then A^c~~

④ If $A \subseteq B$, we need to show $A^c \subseteq B^c$

~~x∈~~ let x .

~~② A If A-B, we need to show A~~

② $A - B = A \cap B^c \longrightarrow$ let $x \in A - B$

a. (i) ~~Since~~ $x \in A$ and $x \notin B$
$x \in A$ and $x \in B^c$
then $A \cap B^c$

2/2

(ii) b. otherwis, $A \cap B^c$ (then $A - B$)

~~let $x \in A$ and $x \in B^c$~~

let $x \in A \cap B^c \rightarrow$ then $x \in A$ and $x \in B^c$

so $x \in A$ and $x \notin B$ so $(A - B)$

~~so $A \cap B'$~~

L.H.S $\subseteq$ R.SH

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M. Saleh

qz3- Spring Semester 2014/2015

Student Name: سلا خضير Number: 1122003 Section 12

Q1 (5 points) Prove or disprove each of the following:

0.5 (1) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B^c$.

2 (2) $A - B = A \bigcap B^c$.

1 (3) State De Morgan's Laws

1 (4) If $A \subseteq B$, then $A^c \subseteq B^c$

(1) Let A, B be two sets such that $A \cap B = \phi$

Let $A \cap B = \phi$ we need to show that $A \subseteq B^c$

Let $x \in \cancel{A \cap B}$?? $\cancel{\text{so}}$ $x \in A$ and $x \notin B$

so $x \in A$ and $x \in B^c$

so $x \in A$ and $x \in B^c$

so $x \in A \subseteq B^c$

0.5/1

(2) $A - B = A \cap B^c$ RHS $\subseteq$ LHS

Let $x \in A - B$

so $x \in A$ and $x \notin B$

so $x \in A$ and $x \in B^c$

so $x \in A$ and $x \in B^c$

so $x \in (A \cap B^c)$

Let $x \in A \cap B^c$ LHS $\subseteq$ RHS

so $x \in A$ and $x \in B^c$

so $x \in A$ and $x \notin B$

so $x \in A - B$

2/2

(3) (1) $(A \cap B)^c = A^c \cup B^c$

(2) $(A \cup B)^c = A^c \cap B^c$

(4) False, ~~A~~ $U = \{1, 2, 3, 4, 5, 6\}$

Counter example $\Longrightarrow$ $A = \{1, 2, 3\}$

$B = \{1, 2, 3, 4\}$

so $A \subseteq B$

$A^c = \{4, 5, 6\}$

$B^c = \{5, 6\}$

$B^c \subseteq A^c$

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M. Saleh

qz4

Spring Semester 2014/2015

Student Name: لينا مرداوي Number: 1131197 Section (1: SMW), (2:TWR)

Q1 (5 points) Answer the following statements by true or false:

T (1) For any set A, $A \in P(A)$.

F (2) If A, B are disjoint then A^c, B^c are disjoint.

?? T (3) $A - B = A \cap B^c$.

F (4) $(A \cap B)^c = A^c \cap B^c$.

T (5) $\phi \in \{\phi\}$ and $\phi \subseteq \{\phi\}$.

F (6) The only an inductive set that contains 1 is $\cancel{Z}$. N

T (7) The set union of two inductive sets is an inductive set.

T (8) The set intersection of two inductive sets is an inductive set.

F (9) The power set of an inductive set is an inductive set.

F (10) Any statement and its converse are equivalent.

5/5

Q3 (5 points) Prove or disprove each of the following:

1 (1) For any sets A, B, If $A \subseteq B$ then $P(A) \subseteq P(B)$

Assume $A \subseteq B$, Show that $p(A) \subseteq p(B)$

Let $\{x\} \in p(A)$ So $x \in A$ Since $A \subseteq B$ So $x \in B$ So $\{x\} \in p(B)$

$x \in P(A)$

So $p(A) \subseteq p(B)$.

1 (2) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B$. (False)

Counter example: $A = \{1, 2\}$

$B = \{3, 4\}$

$A \cap B = \phi$ But $A \not\subseteq B$.

1 (3) $A - B = A \bigcap B^c$.

$x \in (A - B) \Leftrightarrow x \in A$ And $x \notin B$

$\Leftrightarrow x \in A$ And $x \in B^c$

$\Leftrightarrow x \in (A \cap B^c)$

LHS $\subseteq$ RHS
And RHS $\subseteq$ LHS
So LHS = RHS.

1 (4) $(A \bigcup B)^c = A^c \bigcap B^c$

$x \in (A \cup B)^c \Leftrightarrow x \notin A$ And $x \in B^c$

$\Leftrightarrow x \notin A^c$ And $x \notin B^c$

$x \notin$

Let $x \in (A^c \cap B^c)$

$\Leftrightarrow x \in A^c$ And $x \in B^c$

$\Leftrightarrow x \notin A$ And $x \notin B$

$\Leftrightarrow x \notin A \cup B$

$\Leftrightarrow x \in (A \cup B)^c$

So LHS $\subseteq$ RHS And RHS $\subseteq$ LHS So LHS = RHS.

1 (5) For any positive integer n, $\boxed{n^2 - n}$ is always an even integer

Assume n is a positive integer, need to show $n^2 - n$ is even.

Case 1: $\boxed{n \text{ is even.}}$ So $\exists k \in \mathbb{Z}$ such that $n = 2k$.

$n^2 - n = (2k)^2 - (2k) = 4k^2 - 2k = 2(2k^2 - k) = 2k'$ $\quad k' = 2k^2 - k \in \mathbb{Z}$

So $n^2 - n$ is even.

Case 2: $\boxed{n \text{ is odd}}$ So $\exists c \in \mathbb{Z}$ such that $n = 2c + 1$

$n^2 - n = (2c+1)^2 - (2c+1) = 4c^2 + \underbrace{4c + 1 - 2c - 1}_{2c}$

$= 2(2c^2 + c) = 2c'$ is even $\quad c' = 2c^2 - c \in \mathbb{Z}$

5/5

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M. Saleh

qz3- Spring Semester 2014/2015

Student Name: لينا مرياوي Number: 1131197 Section 1 SMW

Q1 (5 points) Prove or disprove each of the following:

1 (1) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B^c$.

1 (2) $A - B = A \bigcap B^c$.

1 (3) State De Morgan's Laws

2 (4) If $A \subseteq B$, then $A^c \subseteq B^c$

$x \in B^c \rightarrow x$

(3) $(A \cup B)^c = A^c \cap B^c$

$(A \cap B)^c = A^c \cup B^c$

1/1

---

(1)

~~$x \in B^c \xrightarrow{A \subseteq B} x \in A$~~

~~$x \notin B$ And $x \in A$~~

~~$x \notin A \cap B \longrightarrow$ So $A \cap B = \phi$~~

Suppose $A \cap B = \phi$ need to show $A \subseteq B^c$

1/1

Suppose $\boxed{x \in A}$ Since $A \cap B = \phi$ - So $x \notin B$

So $x \in B^c$

$\longrightarrow A \subseteq B^c$

5/5

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qz3- Spring Semester 2014/2015

Student Name: لينا مرباوي Number: 1131197 Section 1 SMW

Q1 (5 points) Prove or disprove each of the following:

1 (1) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B^c$.

1 (2) $A - B = A \bigcap B^c$.

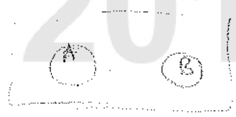
1 (3) State De Morgan's Laws

2 (4) If $A \subseteq B$, then $A^c \subseteq B^c$

$x \in B^c \rightarrow x$

(3) $(A \cup B)^c = A^c \cap B^c$

$(A \cap B)^c = A^c \cup B^c$ 1/1



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(1) ~~$x \in B^c \xrightarrow{A \subseteq B} x \in A$~~

~~$x \notin B$ And $x \in A$~~

~~$x \notin A \cap B \longrightarrow$ So $A \cap B = \phi$~~

Suppose $A \cap B = \phi$ need to show $A \subseteq B^c$. 1/1

Suppose $\boxed{x \in A}$ Since $A \cap B = \phi$ - So $x \notin B$

So $x \in B^c$

$\Longrightarrow A \subseteq B^c$

115/12 Excellent :)

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M. Saleh

qz2- Spring Semester 2014/2015

Student Name: لينا مرياوي Number: 1131197 Section 1

Q1 (5 points) **Prove or disprove each of the following:**

2(F) (1) If a, b, c positive integers such that a divides bc, then a divides b or a divides c

2 (2) An integer a is even iff a^2 is even.

1.5 (3) $\frac{1}{x} < \frac{1}{2}$ iff $x > 2$ or $x < 0$.

2(F) (4) $\sqrt{2}$ is rational

2 (5) Let $p_1, p_2, \ldots, p_n$ be distinct prime numbers. Show that $\boxed{p_1 p_2 \ldots p_n + 1}$ is not divisible by any p_i, $i = 1, \ldots, n$

2 (6) Let n be a positive integer. Show that n is either a prime number, or a perfect square or $(n-1)!$ is divisible by n

(1) $bc = ak_1 \longrightarrow b = ak_2$ or $c = ak_3$ $k_i \in \mathbb{Z}$

Take $b = 3$, $c = 6$, $a = 2$ — $3(6) = 2k_1$, $18 = 2(9)$ $\longrightarrow$ $3 = 2k_2$ X $6 = 2k_3$, $6 = 2(3)$

$\nexists\, k_2 \in \mathbb{Z}$ such that $3 = 2k_2$.

2/2

(2) ($\Rightarrow$) If a is even, Then a^2 is even.

(Let a is even, need to show that a^2 is even).

a is even, So $\exists\, m \in \mathbb{Z}$ such that $a = 2m$ $\Rightarrow a^2 = 4m^2 = 2(2m^2) = 2k'$

$k' \in \mathbb{Z}$ $(k' = 2m^2)$. $a^2 = 2k'$ so a^2 is even.

2/2

($\Leftarrow$) If a^2 is even, then a is even.

Proof by Contrapositive. ($\neg q \to \neg p$)

~~Assume~~ If a is odd, then a^2 is odd. (a is odd, need to show that a^2 is odd)

a is odd so $\exists n \in \mathbb{Z}$ such that $a = 2n+1 \Rightarrow a^2 = 4n^2+4n+1$

$a^2 = 2(2n^2+2n)+1 = 2k'+1$. $k' \in \mathbb{Z}$ such that $k' = 2n^2+2n$

---

(3) $\frac{1}{x} < \frac{1}{2}$ Iff $x>2$ or $x<0$.

($\Rightarrow$) [If $\frac{1}{x}<\frac{1}{2}$, then $x>2$ or $x<0$]

1.5/2

$\boxed{\frac{1}{x} < \frac{1}{2}}$ Cases: (1) If $x>0$

$1 < \frac{x}{2}$ $2 < x$ and $x>0$ Then $x>2$

(2) If $x<0$

$2 \geq x$ And $x<0$ Then $x<0$

الاكمال على الورقة الثانية

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(4) $\sqrt{2}$ is rational (F) . Since it could be written as $\frac{a}{b}$ and

a, b is in the simple form.

2/2

If we assume that $r = \sqrt{2}$, $r^2 = 2$ is rational then $\exists \frac{a}{b}$ such that $r = a/b$, $b \neq 0$

$r^2 = \frac{a^2}{b^2} \to 2 = \frac{a^2}{b^2}$ $2b^2 = a^2$ So a^2 is even. So a is even. $\Rightarrow a = 2k_1$ ($k_1 \in \mathbb{Z}$) So a, b is not in the simple form. X

$a = \frac{4k^2}{b^2}$ $2b^2 = 4k^2 \to b^2 = 2k^2$ b^2 is even So b is even $\Rightarrow b = 2k_2$ ($k_2 \in \mathbb{Z}$)

Suppose $P_1 P_2 \to P_k$ is prime And

(5) Proof by Contradiction.

$(P_1 P_2 \cdots P_n)+1$ is divisibly by P_i (Since P_i is one of them).

so $[(P_1 P_2 \cdots P_n) + 1]$ is divisibly by P_i $P_1 P_2 \cdots P_n$

2/2

$1 = (P_1 P_2 \cdots P_n) + 1 - (P_1 P_2 \cdots P_n)$ X Since 1 is not prime number.

---

(6) Suppose that n is not a prime number or perfect square, need to show that $(n-1)!$ is divisible by n.

n is not prime So $\exists m, k$ such that $mk = n$ and $m, k \neq 1$

n is not perfect square So $n^2 \neq t^2$ ($t \in \mathbb{Z}$)

$(n-1)! = (1)(2)(3) \cdots \underset{mk}{\vee} \cdots (n-1)$

2/2

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M. Saleh

qz1- spring Semester 2014/2015

Student Name:____________________________**Number:**__________ **Section**____

Q1 (5 points) Answer the following statements by true or false:

T (1) The statement (If f is differntiable then f is continuous) is a proposition.

F (2) The statement (Today is cold) is a proposition.

T (3) The statement (If the square system $AX = b$ has more than one solution then it has a nonzero solution) is a proposition.

F (4) The truth set of: $|x| = 2$ is 2.

F (5) The truth set of: $\frac{1}{x} < \frac{1}{2}$ is all real numbers greater than 2.

F (6) In performing the long division (the division algorithm with quotient and remainder) if we divide -21 by 5 then the quotient is -4 and the remainder is -1

-5 4

Q2 (6 points)

(a) $\sim$ (x is ~~an~~ even integer ~~and~~ But x is not a perfect square) is:

(b) $\sim [z \wedge (x \vee y)]$ is: $[\sim z \vee ((\sim x) \wedge (\sim y))]$

(c) Prove that $\sim (x \vee y)$ is $\sim (x) \wedge (\sim y)$ without using the truth table

(d) Prove that $\sim [(\forall x)(P(x))]$ is $(\exists x)(\sim P(x))$

c) $\sim(x \vee y)$ is True $x \vee y$ is False x And y Both are False $\sim x, \sim y$ Both True
$(\sim x) \wedge (\sim y)$ True.

$(\sim x) \wedge (\sim y)$ is True $\sim x$ And $\sim y$ Both True x, y Both False $x \vee y$ False
$\sim(x \vee y)$ True.

d) $\sim[(\forall x)(P(x))]$ is True $(\forall x)\, p(x)$ is False Truthset isnt the Universe set

$(\exists x)(\sim p(x))$ is True.

$(\exists x)(\sim p(x))$ is True $(\forall x)\, p(x)$ is False $\sim[(\forall x)(p(x))]$ is True

~~11.~~
~~12.~~
~~7.~~
~~33~~
~~21~~
3
32

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M. Saleh

qz4

Spring Semester 2014/2015

Student Name:____________________Number:________ Section (1: SMW), (2:TWR)

Q1 (5 points) Answer the following statements by true or false:

T (1) For any set A, $A \in P(A)$.

F (2) If A, B are disjoint then A^c, B^c are disjoint.

T (3) $A - B = A \cap B^c$.

F (4) $(A \bigcap B)^c = A^c \bigcap B^c$.

T (5) $\phi \in \{\phi\}$ and $\phi \subseteq \{\phi\}$.

F (6) The only an inductive set that contains 1 is Z.

T (7) The set union of two inductive sets is an inductive set.

T (8) The set intersection of two inductive sets is an inductive set.

F (9) The power set of an inductive set is an inductive set.

F (10) Any statement and its converse are equivalent.

Q3 (5 points) Prove or disprove each of the following:

(1) For any sets A, B, If $A \subseteq B$ then $P(A) \subseteq P(B)$

$\{x\} \in P(A) \longrightarrow x \in A$ Since $A \subseteq B$ So $x \in B \longrightarrow \{x\} \in P(B)$

$x \in P(A)$ $\quad x \subseteq A$ $\quad x \subseteq B$ $\quad x \in P(B)$

$P(A) \subseteq P(B)$

F (2) If A, B two sets such that $A \bigcap B = \phi$. Then $A \subseteq B$.

$\cancel{x \in}$ $A = \{1, 2\}$
$B = \{3, 4\}$
$A \nsubseteq B$.

(3) $A - B = A \bigcap B^c$.

$x \in (A - B) \Leftrightarrow x \in A \wedge x \notin B \Leftrightarrow x \in A \wedge x \in B^c \Leftrightarrow x \in (A \cap B^c)$.

(4) $(A \bigcup B)^c = A^c \bigcap B^c$

$x \in (A^c \cap B^c) \Leftrightarrow x \in A^c \wedge x \in B^c \Leftrightarrow x \notin A \wedge x \notin B \Leftrightarrow x \notin A^c \cap \ldots \quad x \in B^c$

$x \in (A^c \cap B^c)$

(5) For any positive integer n, $n^2 - n$ is always an even integer

① ✓
② $\boxed{k^2 - k}$ is even.
③ $(k+1)^2 - k+1$ is even. ~~$k^2 + 2k + 1 - k - 1$ $k^2 + k$ is even~~

$[k+1][k+\cancel{1}-\cancel{1}]$

$k^2 + k^{+k-k}$ is even. from step 2.

~~$k(k+1)+1$~~

~~$k(k-)$~~

$(k^2 - k) + 2k$
even + even = even.